STACK
ANNEX
5
060
757

MECHANICAL DRAWING

STANDARDS AND CONVENTIONS

F. R. KEPLER

A
0
0
0
0
3
8
6
4
2
5
UC SOUTHERN REGIONAL LIBRARY FACILITY

California
gional
cility

STANDARDS AND CONVENTIONS

MECHANICAL DRAWING

STANDARDS AND CONVENTIONS

BY

FRANK R. KEPLER

Cass Technical High School Drafting Department

Revised by

DETROIT MANUAL TRAINING CLUB'S
STANDARDS COMMITTEE

Published under Authority of

THE BOARD OF EDUCATION

DETROIT, MICH

Copyright 1916,
by
FRANK R. KEPLER, *Chairman*

First Issue . . . . October 1915
First Edition . . . March 1916
Second Edition . . . July 1916

Printed in
Cass Technical High School
Detroit, Michigan

PREFACE TO FIRST EDITION

A COMMITTEE on STANDARDS AND CONVENTIONS for Mechanical Drawing was selected by the Executive Committee of the Detroit Manual Training Club.

Copies of a preliminary issue of STANDARDS AND CONVENTIONS for Cass Technical High were used as a basis of inquiry and criticism. These copies were sent out to fifty representative concerns in Detroit and Michigan. The criticisms of a large majority of the representatives of these firms were gathered together, carefully noted, and discussed. Points were finally decided as the consensus of opinion seemed to indicate. School requirements and good educational methods have governed the decision of points which did not seriously conflict with good industrial practice.

This first edition is presented with the hope that these STANDARDS AND CONVENTIONS, determined as stated above, will be generally adopted in the schools.

The chairman takes this opportunity to acknowledge the interest, suggestions, and helpfulness of the various members of the committee.

Signed

F. R. KEPLER, CHAIRMAN
CASS TECHNICAL

L. G. BURGESS, SEC'Y
NORTHWESTERN

P. A. CUMMINS
CASS TECHNICAL

EDWARD GATES
CENTRAL

JOHN F. GRANT
EASTERN

D. W. HICKOK
WESTERN

2065666

PREFACE TO FIRST ISSUE

THE notes and plates for STANDARDS AND CONVENTIONS have been brought together by Mr. P. A. Cummins and myself for use in Cass Technical High School. They are the result of several years' experience in teaching Continuation, Evening, and High School classes, and are a study of the requirements of modern drafting room practices.

Mr. Carnot Iverson, Cass Technical High School, inked in all the drawings for the plates and made the original drawings for Plates 15 and 16.

Friendly criticisms of our initial copy will be greatly appreciated as it is our endeavor to meet the best drafting-room practices.

FRANK R. KEPLER

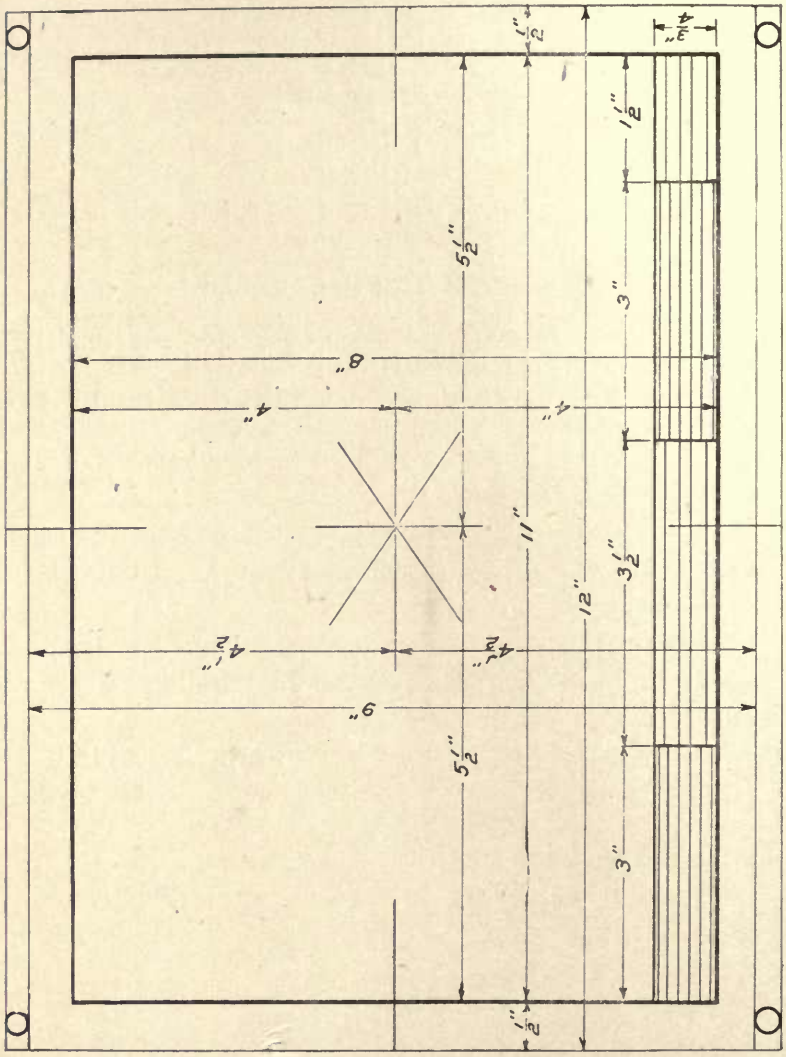


PLATE 1

GENERAL DIRECTIONS AND NOTES

DIRECTIONS

For Laying Out D-size Sheets

Place a sheet of drawing paper 9½″ by 12″ upon the drawing board so that the upper edge is in line with the tee-square. Placing the tee-square diagonally across the paper from corner to corner, draw portions of the diagonals near the center to find the exact center of the sheet. Now through he center draw a horizontal and a vertical line across the paper. Measure 4½″ above the center and 4½″ below the center; through the points thus found draw horizontal lines. These two lines are the cutting lines along which to trim the finished drawing, making the sheet 9″ by 12″. Again measure 5½″ to the right and 5½″ to the left; through these points draw vertical lines. Next measure 4″ above the center along the vertical line and 4″ below the center and through these points draw horizontal lines. These four border lines enclose a rectangle 8″ by 11″. Observe Plate 1.*

A title block is used in all cases. The title block will appear in the lower right hand corner, arranged as shown in Plate 3. The title block should be penciled in complete before the drawing itself is begun.

Guide lines in pencil should be drawn for the tops and bottoms of all letters but must not be drawn in ink.

Each drawing shall first be done in pencil and submitted to the instructor for approval or corrections. The drawing is to be inked when it has been approved by the instructor and he has placed the word "INK" on the margin.

When the drawing is finished, it shall again be submitted for final approval before the word "INK" is cut off. It shall then be trimmed to the proper size and handed in.

One plate from each set may be retained as the property of the school.

---

*The sheet may be laid out without first finding the center, but the distance from the upper to the lower cutting lines must be 9″ and the border rectangle must be 8″ by 11″.

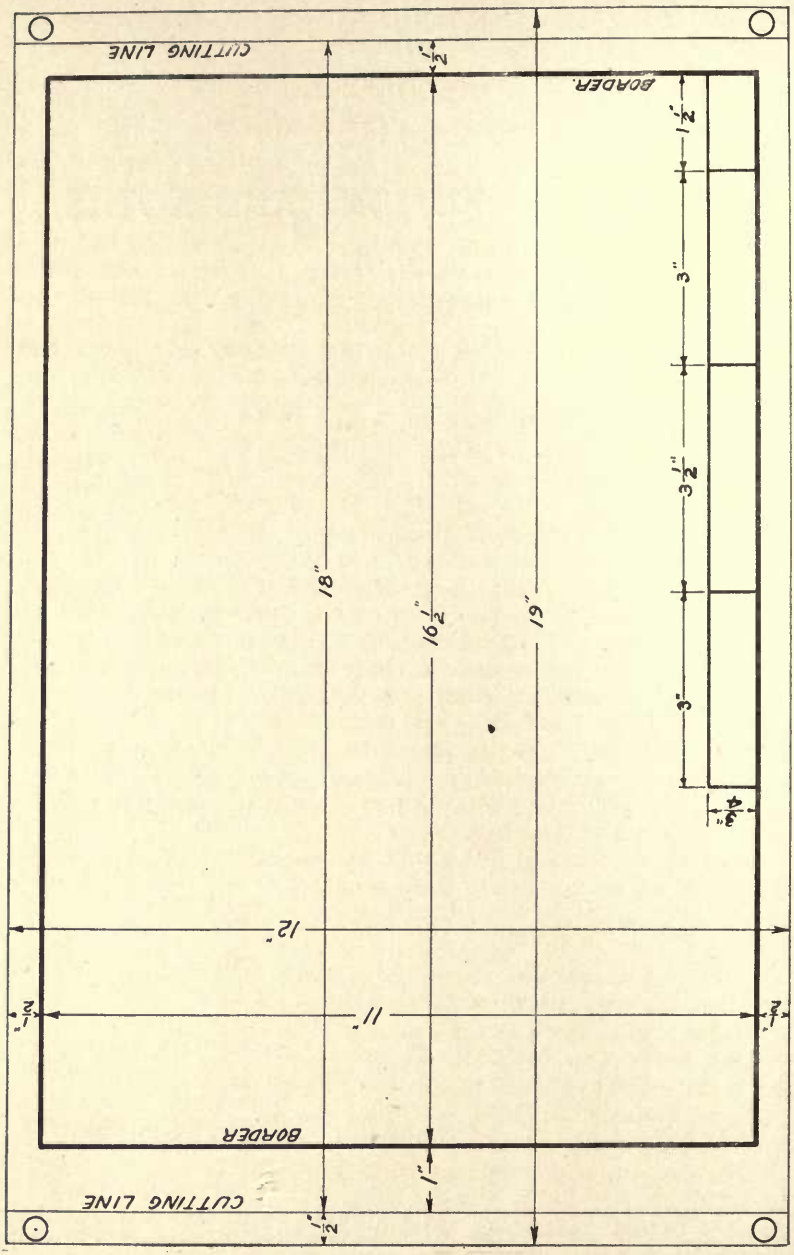

CUTTING LINE
BORDER
1/2"
1 1/2"
3"
3 1/2"
3"
1/4"
18"
16 1/2"
19"
12"
11"
1/2"
1/2"
BORDER
CUTTING LINE
1"
1/2"

PLATE 2

DIRECTIONS

For Laying Out C-size Sheets

Place the sheet of drawing paper, provided for the purpose, on the drawing board so that one of the long sides is even with the upper edge of the T-square. Draw a vertical line ½″ from the left-hand edge and another 18″ to the right of the first. These two lines are the cutting lines along which the sheet is to be trimmed thus removing the thumb-tack holes when the drawing is completed. Leaving 1″ margin at the left and ½″ margin on the other three sides, draw a border rectangle 11″ x 16½″. Observe Plate 2.

Unless otherwise directed, a title block is to be placed in the lower right-hand corner. This title block is to contain the name of the school, the title of the drawing, by whom drawn, by whom traced, and checked as well as approved, and th enumber of the drawing. It is to be spaced and arranged as shown in Plate 3.

A Bill of Material is generally placed on all drawings for shop purposes and erecting. This list must contain the number of parts, the material of which they are made, the name of the part, the reference number on the drawing and, if a pattern is required, the pattern letter. (The pattern number consists of the drawing number and the letter; thus, PATT. C-204A). The letters of the Bill of Material are 3/32″ high, and the columns are arranged as shown in Plate 4. It may be placed in any convenient space on the drawing but preferably above the title-block. The listing of the parts begins at the bottom, a few spaces being left at the top for the listing of additional parts if occasion demands it. Such standard parts as bolts, machine screws, washers, etc., are listed but are **NOT DRAWN.**

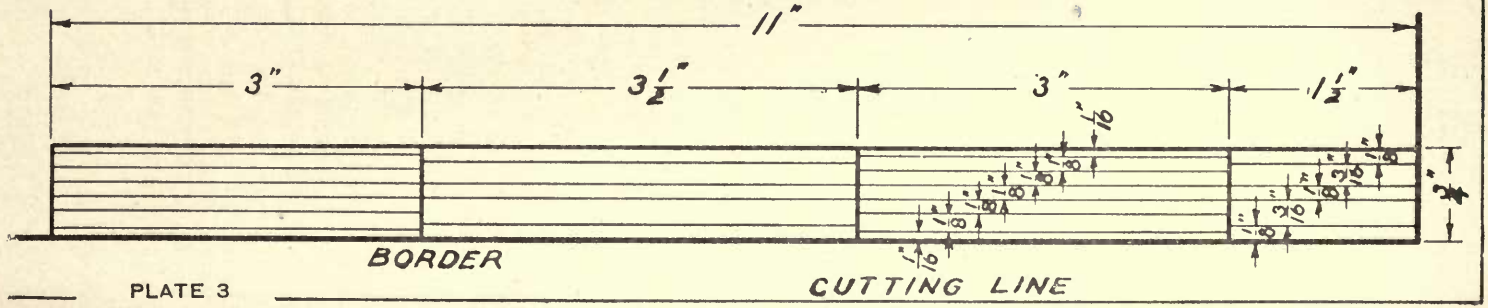
The cutting-lines, border rectangle, title block, and bill of material must all be arranged properly in pencil before the drawing itself is begun. Be careful to make the drawing accurate in pencil, making all corrections before inking any part of the drawing. Do not begin inking until the penciled drawing has been submitted to your instructor for his approval and he has placed the word "Ink" on the margin.

When the drawing has been carefully inked or traced it must again be submitted to the instructor for his final approval before removing it from the drawing board. This approval secured, the finished drawing is to be trimmed to the required size, 12″ x 18″, and handed in.

TITLE BLOCK FOR ALL DRAWINGS.

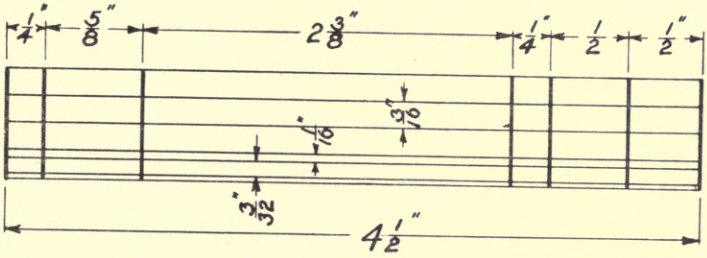
CASS TECHNICAL HIGH SCHOOL _____ DEPT.	ARRANGE TITLE TO SUIT SPACE	DRAWN BY_____ TRCD._____CHKD._____ APRVD. DATE_____	DRAW'G _____

THE NAME OF THE DEPARTMENT SHOULD BE INSERTED IN THE SPACE INDICATED, AS: MECHANICAL DEPT., CONTINUATION DEPT., EVENING SCHOOL. THE DRAWING NUMBER INCLUDES THE LETTER DENOTING SIZE OF SHEET.



BILL OF MATERIAL FOR ALL SHEETS.

2	M. S.	$\frac{1}{2}$" x 3$\frac{1}{2}$" BOLTS, SQ. HDS.	4		
1	C. I.	CAP	3	PATT.	B
4	M. S.	$\frac{1}{2}$" x 4" HEX. BOLTS	2		
1	C. I.	BASE	1	PATT.	A



NOTE

1ST. COLUMN		NUMBER OF PARTS REQUIRED
2ND.	"	MATERIAL
3RD.	"	NAME OF PART
4TH.	"	REFERENCE NUMBER
5TH.	"	ABBREVIATION FOR PATTERN
6TH.	"	PATTERN LETTER

MAKE THE VERTICAL LINES MEDIUM, THE HORIZONTAL LINES FINE, BUT OMIT THE GUIDE LINES FOR THE LETTERING WHEN INKING.

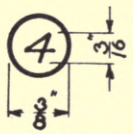
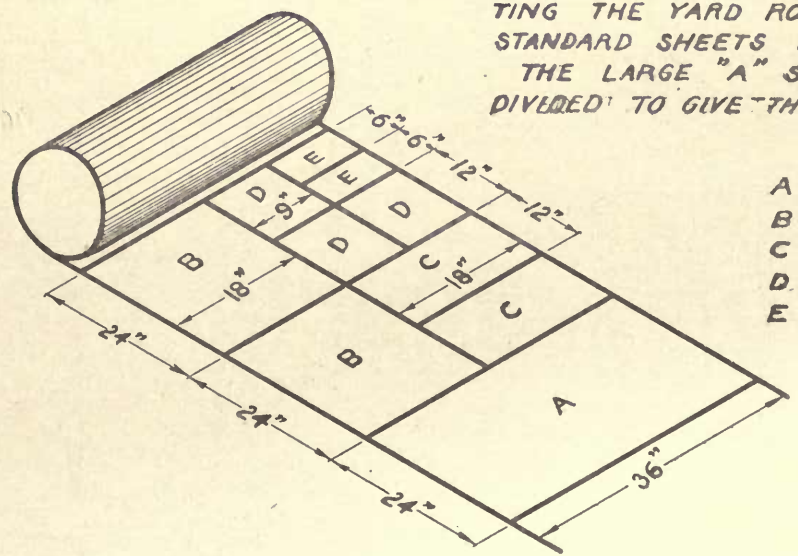
REFERENCE NUMBER 

PLATE 4

STANDARD SIZES OF SHEETS.

THE MOST ECONOMICAL METHOD OF CUTTING THE YARD ROLL TO OBTAIN THE STANDARD SHEETS IS SHOWN IN FIG. 11. THE LARGE "A" SHEET MAY BE SUBDIVIDED TO GIVE THE SMALLER SIZES.



A =	FULL	SHEET	= 24" X 36"
B =	$\frac{1}{2}$	SHEET	= 18" X 24"
C =	$\frac{1}{4}$	"	= 12" X 18"
D =	$\frac{1}{8}$	"	= 9" X 12"
E =	$\frac{1}{16}$	"	= 6" X 9"

NOTE
ALL DRAWINGS MUST BE MADE ON STANDARD SHEETS.

PLATE 5

STANDARDS AND CONVENTIONS

P. A. Cummins—F. R. Kepler.

The following conventions and standards are to be followed in making all drawings:

1. The sizes of drawings shall be 6″ x 9″, 9″ x 12″, 12″ x 18″, 18″ x 24″ and 24″ x 36″ and with border lines as indicated in Plates 1 and 2. These sizes are chosen for the reason that commercial stock may more readily be cut to these dimensions and the smaller can be cut from the larger without waste. Plate 5.

2. The letters and figures used for notes and dimensions shall be after the form adopted—inclined right line lettering. Plate 6.

3. All notes on drawings shall be made with capital letters 3/32″ high, made between light guide-lines that distance apart.

4. .Figures must be made of the same height. Fractions are to be made higher than the whole numbers and with the division line horizontal. Plate 6.

5. The conventional lines of the kinds and weights shown are to be used as required to give a contrast between the object and other lines. The beginner often makes his object lines too light. Plate 6.

6. Arrow heads are always to be made narrow. They must not be large and spread out. Plate 4.

7. The Title and Bill of Material are to be laid out as shown in Plates 3 and 4. The Bill of Material must contain drawing and, if a pattern is required, the pattern letter or number. It may be placed in any convenient space on the drawing but preferably above the title block. The listing of the parts begins at the bottom, a few spaces being left at the top for the listing of additional parts if occasion demands it.

8. Each part shall have a Reference Number, whether the part is detailed on the drawing or is a standard part. Each number is to appear on or near the piece if detailed; if standard it is to be placed near where it belongs, an arrow showing the exact location. Each number is to be 3/16″ high and be placed within a heavy circle ⅜″ in diameter, the number being of the same weight. The number should be made first

A B C D E F G H I J K L M N O P Q R S T U V

W X Y Z

1 2 3 4 5 6 7 8 9 10

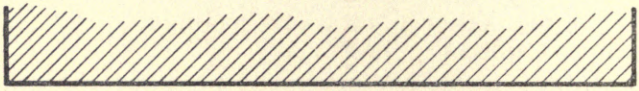
$\frac{1}{2}$ $\frac{3}{4}$ $\frac{5}{8}$ $450\frac{7}{16}$

CONVENTIONAL LINES

BORDER LINE

VISIBLE EDGE

HIDDEN EDGE



REFERENCE LINE

$4\frac{1}{2}$"

DIMENSION LINE

CENTER LINE

PROJECTION LINE

CORRECT

WRONG

PLATE 6

and then the circle drawn, so that the number will appear in the exact center of the circle. A corresponding number shall appear in the Bill of Material with the name of the part. Plate 4.

9. The numbering of the drawings shall be on the following basis: The size of the sheets shall be designated as A for 24″ x 36″, B for 18″ x 24″, C for 12″ x 18″, D for 9″ x 12″ and E for 6″ x 9″. Plate 5.

Drawings in the first year shall be numbered from 101 to 199; the second year 201 to 299; the third year 301 to 399; and the fourth year 401 to 499. The first figure tells at once in what school year the drawing is made and the last figures give the consecutive number of the drawing. This is further divided by having all second term drawings begin with 151, 251, etc. Thus the sixth drawing of the second term of the first year made on a 12″ x 18″ sheet would be C-156. Drawings to be used in the various shops of the school must be numbered consecutively beginning with 1101 preceded by the proper letter designating the size; thus: D-1102. A record of each drawing shall be kept.

10. Patterns will be listed A, B, etc., in the bill of material. Hence pattern B on Drawing C-156 would be Patt. C-156 B. Plate 4.

CONVENTIONAL LINES

(See Plate 6)

11. Border lines shall be heavy full lines, from 1/32″ to 1/16″ wide.

12. Visible edges and outlines of objects shall be represented by full lines of medium width.

13. Hidden edges and outlines of objects shall be represented by broken lines, consisting of short ⅛″ dashes, somewhat lighter than medium lines, separated by 1/16″ spaces.

14. Dimension lines shall be fine, solid lines, interrupted for the figures expressing the dimension and terminated by long, narrow arrow-heads; and drawn at least ¼″ from the object.

15. Reference, or extension lines shall be fine, full lines, drawn at right angles to the edge measured, from a point 1/32″ from the edge and projecting 1/16″ beyond the arrow head.

16. Center lines shall be fine, broken lines, consisting of long ⅝″ dashes, separated by single 1/16″ dots and 1/16″ spaces.

17. Projection or Construction lines, including all lines not essential outlines or edges of the object represented, shall be fine 1/16″ dotted lines. These are seldom inked.

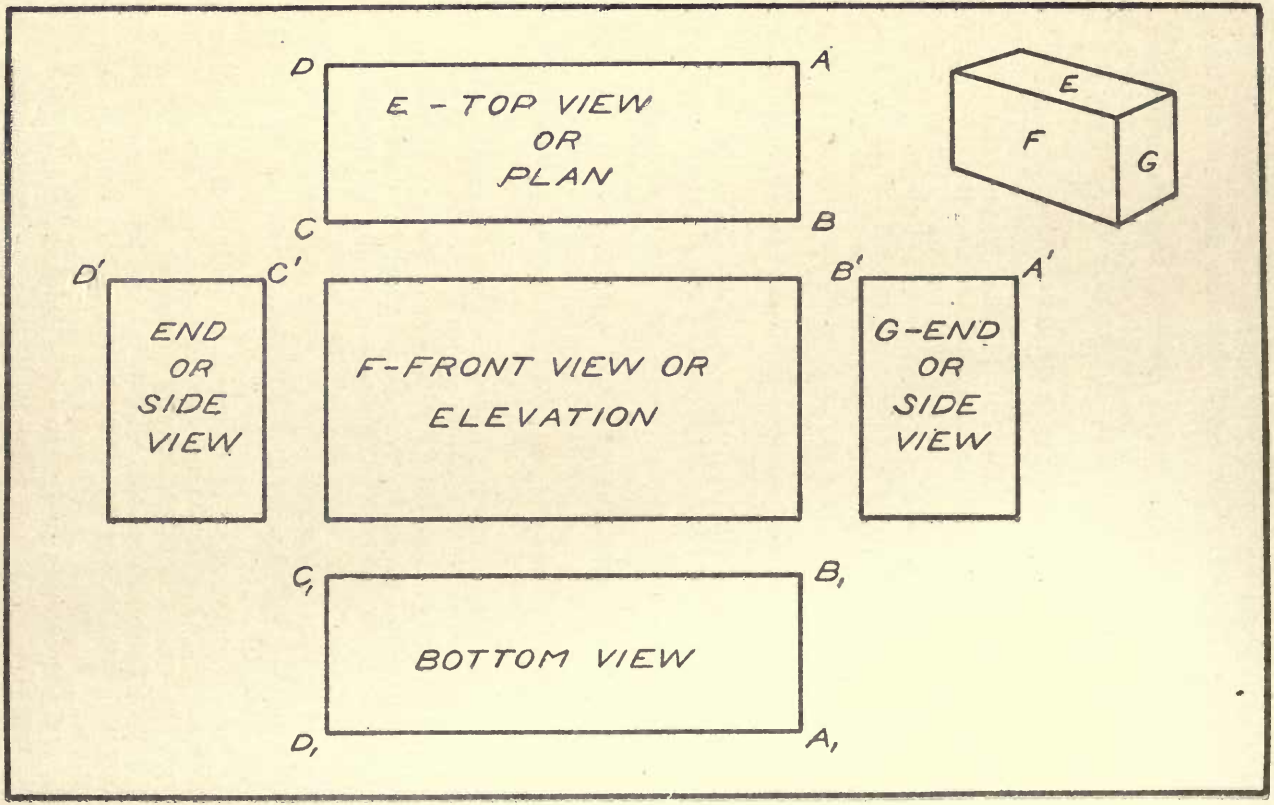

D
A
E - TOP VIEW
OR
PLAN
C
B
E
F
G
D'
C'
B'
A'
END
OR
SIDE
VIEW
F-FRONT VIEW OR
ELEVATION
G-END
OR
SIDE
VIEW
C,
B,
BOTTOM VIEW
D,
A,

PLATE 7

WORKING DRAWINGS

18. A working drawing is one made for use in a workshop, in building construction, or erecting in the field.

19. The representation of an object on such a drawing must follow the principles of orthographic projection. In all standard drawings the third angle is used. Plate 7.

20. The front view must be placed below the top view, or plan; the end or side elevation at the corresponding side of the front view or elevation; the bottom view below the front elevation. Plate 7. If conditions demand, the end view may be placed at the right or left of the top-view, or plan.

21. Two views are generally needed to represent an object. Three views are often required while more may be necessary. Sometimes one view with a section view is all that is necessary, while in the case of a cylinder one view showing the length with the diameter stated thus: 3″ DIA., will meet all requirements. Select the views that will give the best idea of the piece, avoiding hidden edges. Plate 8, Figs. 1 and 2.

22. Working drawings are made ¾″, 1″, 1½″, 2″, 3″, 4″, 6″, 9″ and 12″ to the foot, that being 1/16, 1/12, ⅛, 1/6, ¼, 1/3, ½, ¾ and full size respectively. Details are made full scale or to as large a scale as possible. Scales are not given on detail drawings. The 2″ and 4″ scales are to be avoided as impractical.

23. Drawings are made either of the separate parts or of the various parts properly assembled. The former are styled detail drawings; the latter assembly drawings.

24. Drawings are made of objects as they would naturally appear in use or in the assembled whole.

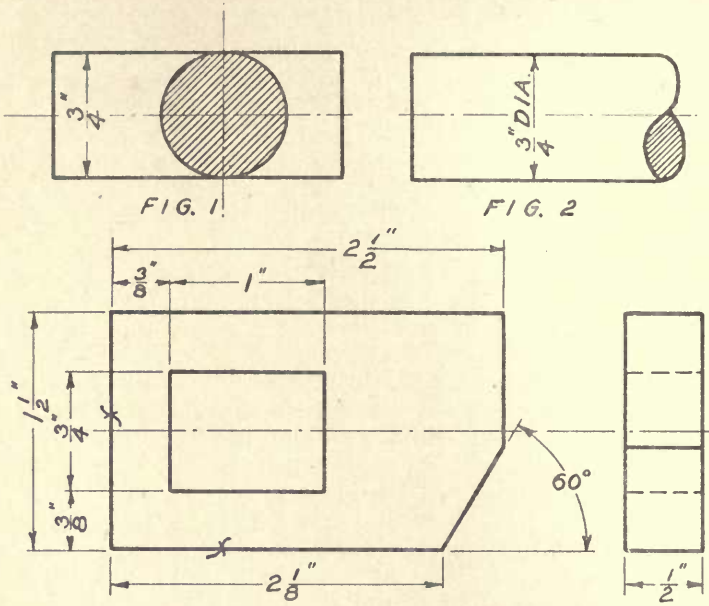
25. Show all details as near to full size as possible consistent with size of sheet.

ASSEMBLY DRAWINGS

26. The assembly drawing is designed to show the interrelation of the parts, the space occupied by the machine, the name and number of each part, the method of fastening, center line distances which can be checked in erecting, etc. The assembly drawing is usually made more elaborate than the detail in that shading may be done at times, threads drawn in their true form, or gear teeth shown, etc.

27. The assembly may be sectioned in part to show the interior, the working of the component parts, etc.

28. In engine and machine drawings it is permissible to omit in one view some construction which is sufficiently


3/4"
FIG. 1
3/4" DIA.
FIG. 2
2 1/2"
3/8"
1"
1 1/2"
3/4"
3/8"
60°
2 1/8"
1/2"
FIG. 3

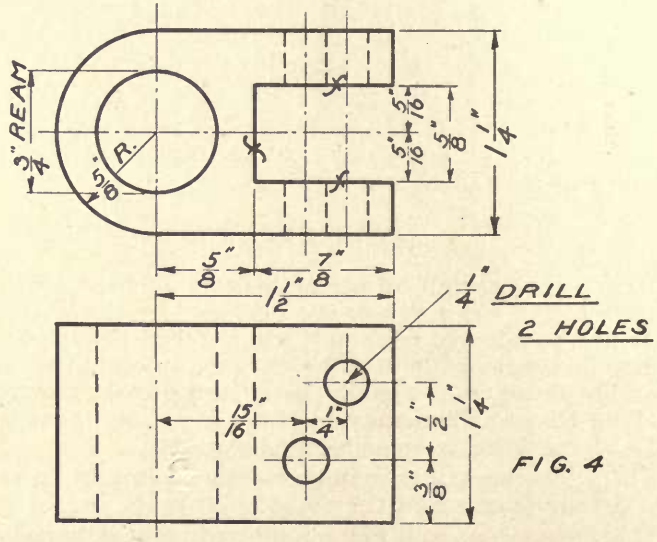

3/4" REAM
R.
5/16"
5/16"
5/16"
5/8"
1 1/4"
5/8"
7/8"
1 1/2"
1/4" DRILL
2 HOLES
15/16"
1/4"
1 1/2"
1 1/4"
3/8"
FIG. 4

PLATE 8

shown in another view. This permits the showing of details in the mechanism which would otherwise be obscured.

29. Preliminary assemblies are usually made full size from sketches and are used by the designer in working out the action of the mechanism.

30. Partial assemblies are made to show the details of any system connected with the machine, as the lay-out of wiring, piping, etc.

31. Piping and wiring drawings are often made in isometric form that is similar to a photograph in which one picture may show top, front and all details. Such a drawing aids the workman as it shows at a glance the location of all couplings, valves, tees, elbows, etc.

DIMENSIONS

32. The drawings are dimensioned the actual size of the piece regardless of the scale.

33. Dimensions and notes must be at least $\frac{1}{4}$" from the drawing. Plate 8, Figs. 3 and 4.

34. Dimensions are placed so as to read either from the right-hand side of the drawing or from the bottom. Plate 8 and Plate 10.

35. All notes are placed either horizontally or vertically, never at an angle. Plate 8, Fig. 4.

36. Everything must read from the lower and right-hand side of the sheet. Plates 8, 9 and 10.

37. Dimension figures, including fractions, are placed at the center of the dimension line, unless the space is very limited, in which case the arrow-heads and figures are placed on the outside of the space dimensioned. Plate 10.

38. The common fractions in $\frac{1}{2}$'s, $\frac{1}{4}$'s, $\frac{1}{8}$'s, 1/16's, 1/32's, 1/64's only are used. Where very accurate work is demanded, decimals are used.

39. The division-line of fractions must be in line with the dimension line, and never inclined. Plate 10.

40. On drawings of machinery inches are used up to 48". 48 inches and above are expressed in feet and inches, thus: 4 FT. 10 IN.. Plate 10. Where all dimensions are in inches the inch marks may be omitted. Plate 2

41. Inches alone are used in drawings of furniture and much cabinet work and interior finish. This is also the general practice in the automobile industry.

42. Over all dimensions should be placed well outside the drawing; shorter dimensions are placed inside these.

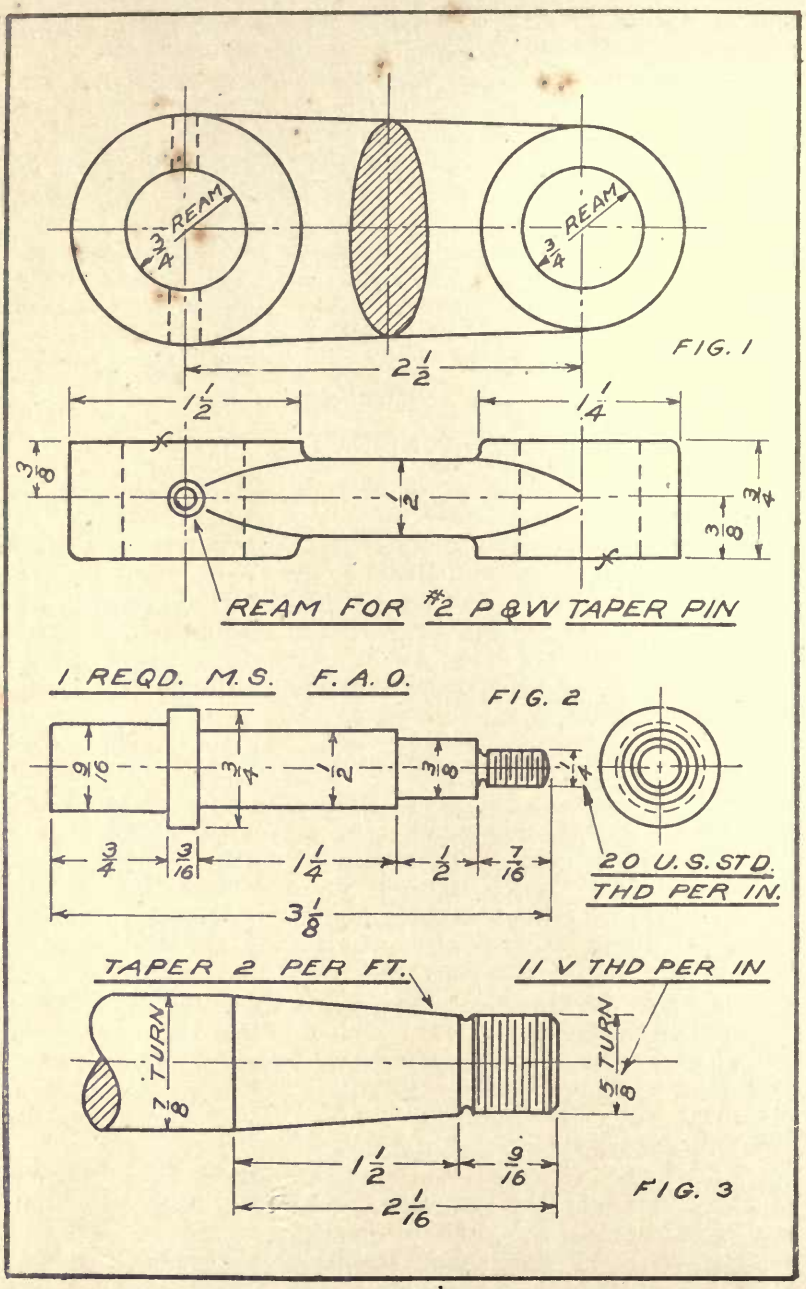

REAM
3/4
REAM
3/4
FIG. 1
2 1/2
1 1/2
1 1/4
3/8
1/2
3/8
3/4
REAM FOR #2 P&W TAPER PIN
1 REQD. M.S. F.A.O.
FIG. 2
9/16
3/4
1/2
3/8
1/4
3/4
3/16
1 1/4
1/2
7/16
3 1/8
20 U.S.STD.
THD PER IN.
TAPER 2 PER FT.
11 V THD PER IN
1 TURN
7/8
5/8 TURN
1 1/2
9/16
2 1/16
FIG. 3

PLATE 9

Plates 8 and 9. A series of dimensions should be so arranged as to facilitate checking.

43. Dimensions must not be too far removed from the part dimensioned. Measurements are placed so as to aid the checker and the workman. Dimensions are often well placed between the views.

44. Keep dimensions off the figure except where there is a possibility of confusing the workman. Plate 8, Fig. 2.

45. Keep related dimensions, i. e., a length and width, on the same view if possible.

46. Dimensions given in one view must not be repeated in another.

47. Avoid dimensioning from hidden edges.

48. Never use center lines for dimensions.

49. Base dimensions from center lines and finished surfaces. Make the drawing fool proof by tying up all holes or cuts to center lines or finished surfaces. Plate 8, Fig. 4; Plate 9, Fig. 1.

50. Place center lines through the centers of all circles and symmetrical drawings. Show center lines for every hole. Plate 9.

51. Dimension to center lines of circles, not to circumferences. Plate 9, Fig. 1.

52. Circles are dimensioned by their diameters; arcs by their radii. All Radii should be marked R or Rad and all diameters Dia or D, Ream, Turn, Bore, Core, etc. Plate 9, Fig. 1, and Plate 10.

53. Where there are several diameters in a given length it is better to give them across the length rather than in an end view. Plate 9, Figs. 2 and 3.

54. Never cross a dimension with a line. Break section lines for a dimension or note if placed in a sectional area. Plate 11, Fig. 1.

55. Since shop drawings are not to be scaled give all necessary dimensions for laying out and finishing the work.

56. Drawings are figured for the machinist, cabinet maker, or builder, as the case may be. Be careful to give such dimensions as will be needed by the mechanic in laying out the work. All figuring is up to you. Add all partial dimensions and give "over all." Leave no adding or subtracting for the workmen. This is your job. He has enough to figure out without doing yours.

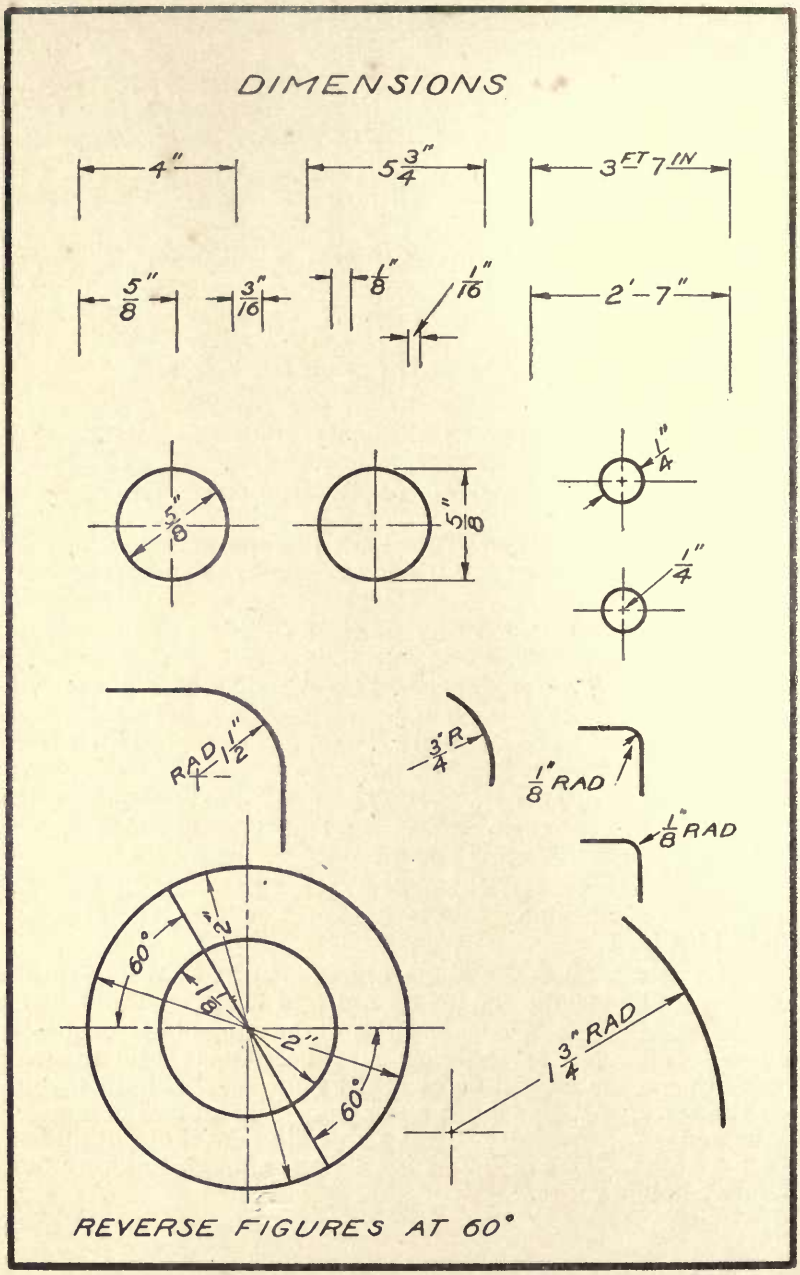

DIMENSIONS
4"
5 3/4"
3 FT 7 IN
5/8"
3/16"
1/8"
1/16"
2'-7"
5/8"
5/8"
1/4"
1/4"
RAD 1 1/2"
3/4" R
1/8" RAD
1/8" RAD
60°
2"
1 1/8"
2"
60°
1 3/4" RAD
REVERSE FIGURES AT 60°

PLATE 10

NOTES

57. Do not be afraid to use explanatory notes. Clearness is all important.

58. All left-hand threads should be plainly marked.

59. Handed pieces should be marked Right (or Left) as shown.

60. On tool details it is customary to add a note below regarding Material, as Tool Steel, etc., etc. Harden and Grind, etc.

61. On tool details the dimensions of the raw stock from which part is to be made are sometimes given.

62. Use abbreviations where possible but be sure the abbreviation is commonly used. The workman reads the drawing not your mind.

SECTION VIEWS

63. A section view shows the surface as made by the passing of a plane through a piece. The purpose of a section is to show the shape of cores, thickness of stock, interior mechanism, and assembly. Plate 11.

64. The point at which a section is made is indicated by a short and long dash line, similar to a center line, and lettered: as A-A. Plate 11, Fig. 1.

65. The surface cut by the plane of section is indicated by lines at 45 degrees spaced in proportion to the size of the drawing, usually about 1/16" apart. Section all details as for cast-iron. The various styles of cross-hatching need not be used to indicate the material, often that for cast-iron and babbitt only being used in actual practice. The material is otherwise stated in connection with the name of the piece. Cross hatch lines for cast-iron and for babbitt are fine. Plate 11.

66. Never section bolts, nuts, screws, shafts, spindles, keys, arms of wheels (lengthwise), gear-teeth, etc. Plate 11, Fig. 2, Plate 12, Fig. 1.

67. Never show hidden edges behind the line of section, unless clearness positively demands it.

68. Make half section rather than full section views. Plate 11.

69. Adjoining section areas have section lines running in opposite directions. Plate 11.

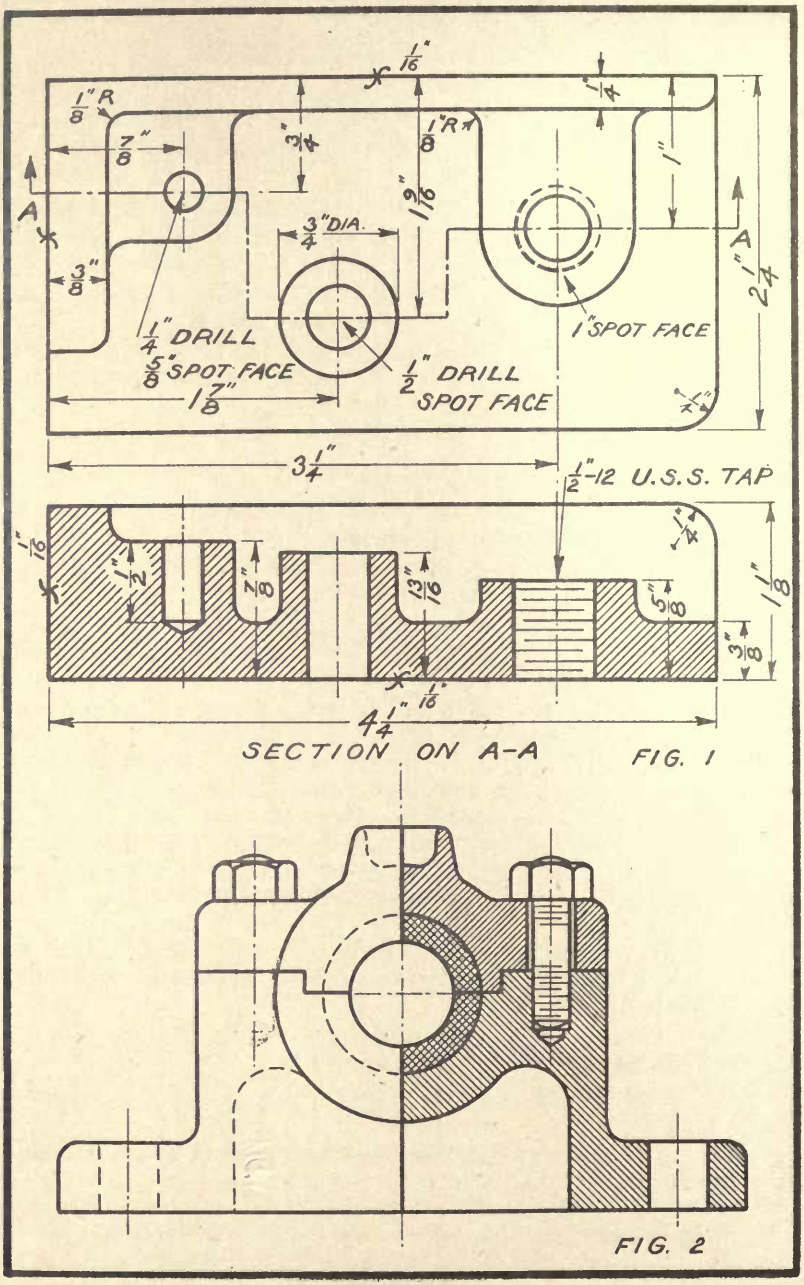
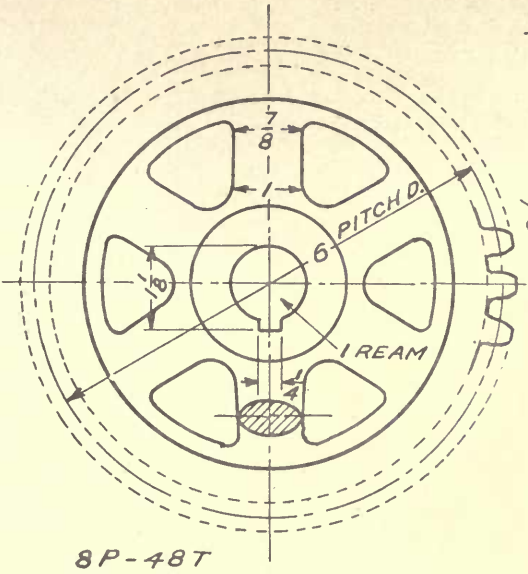
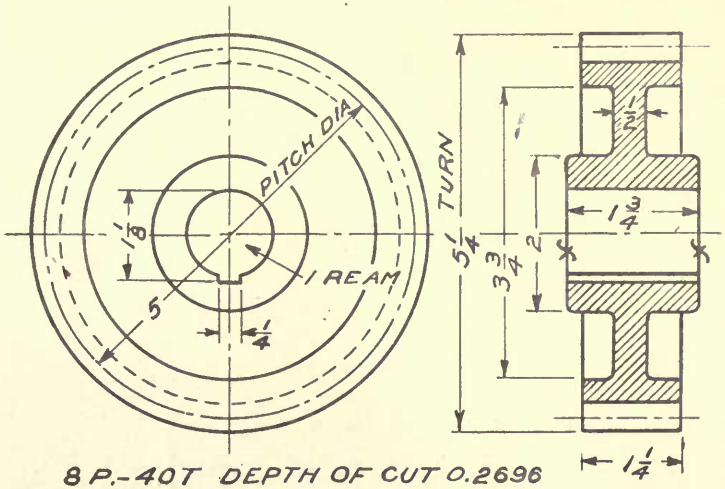

1/16"
1/8" R
7/8"
3/4"
1" R
1/4"
1"
A
A
3/8"
3/4" DIA.
1 9/16"
2 1/4"
1/4" DRILL
5/8" SPOT FACE
1 7/8"
1/2" DRILL
SPOT FACE
1" SPOT FACE
1/16"
3 1/4"
1/2"-12 U.S.S. TAP
1/4"
1/16"
1/2"
1/8"
13/16"
5/8"
1 1/8"
3/8"
4 1/4"
SECTION ON A-A
FIG. 1
FIG. 2

PLATE 11



8P-48T

FIG. 1 CAST SPUR GEAR



8 P.-40T DEPTH OF CUT 0.2696

FIG. 2. CUT SPUR GEAR

PLATE 12

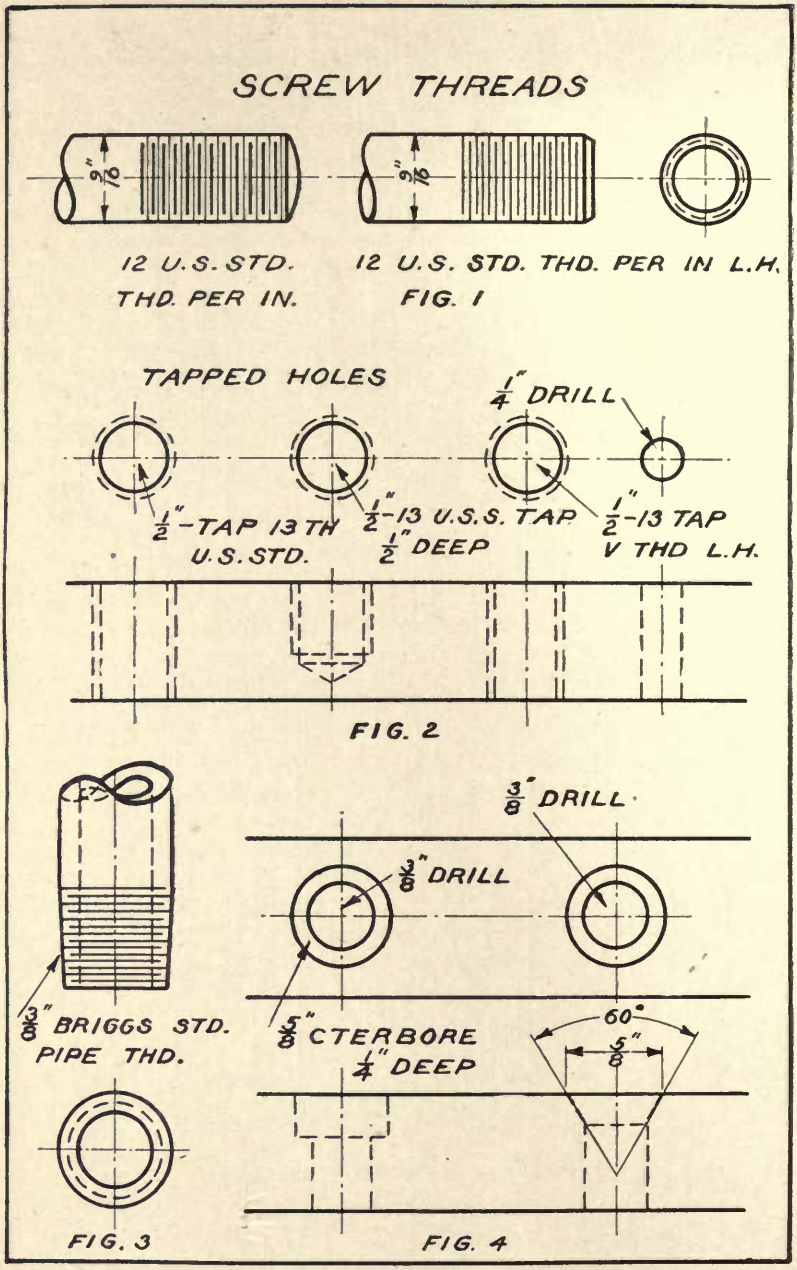

SCREW THREADS
9/16"
9/16"
12 U.S. STD. THD. PER IN.
12 U.S. STD. THD. PER IN L.H.
FIG. 1
TAPPED HOLES
1/4" DRILL
1/2"-TAP 13 TH U.S. STD.
1/2"-13 U.S.S. TAP 1/2" DEEP
1/2"-13 TAP V THD L.H.
FIG. 2
3/8" BRIGGS STD. PIPE THD.
3/8" DRILL
3/8" DRILL
5/8" CTERBORE 1/4" DEEP
60°
5/8"
FIG. 3
FIG. 4

PLATE 13

THREADS

70. U. S. Standard and V-threads should be indicated by alternate light and heavy lines. The diameter and pitch should always be given. Plate 13. Either method as shown in Fig. 1 may be used.

71. Any other than the standard thread should be stated in a note. If a screw has a left-hand or multiple thread, a note should call attention to the fact. Plate 13, Fig. 3.

72. A tapped hole should be shown by a circle indicating the size of the drill and a larger concentric circle in hidden edge line, indicating the size of the tap. A note should state the diameter and number of the tap, thus: 1″-8 TAP. U. S. Std. Plate 13.

73. Never make detail drawings of standard screws, bolts and nuts.

FINISH

74. The finish mark, "*f*," made crossing the line indicating the surface finished, shows that the surface is to be finished as left smooth by the tools. Plate 8, Fig. 4; Plate 9, Fig. 1. A small fraction placed a little above and to the right of the finish mark indicates the amount required for finishing. Plate 11, Fig. 1.

75. Other special finishes as turn, bore, drill, knurl, ream, spot-face, as well as core, are so stated on the drawing. Plate 9 and Plate 13.

76. If a piece is to be finished all over, the note, "Finish all over" (F. A. O.), may be placed near the drawing of the piece or in connection with its name in the bill of material. Plate 9, Fig. 2.

77. On all machine parts use following note: "Remove all burs," "Break all sharp machined edges."

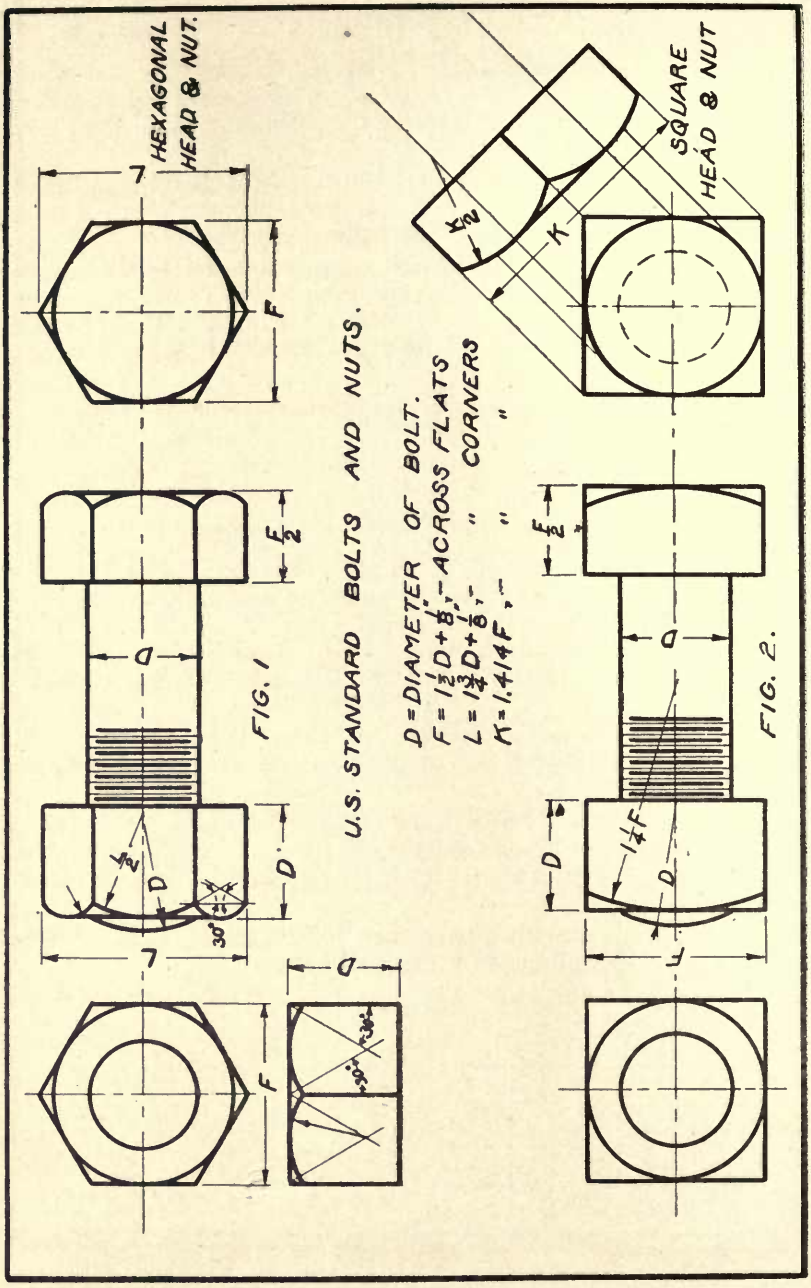
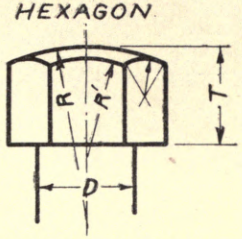

HEXAGONAL HEAD & NUT.
SQUARE HEAD & NUT
U.S. STANDARD BOLTS AND NUTS.
D = DIAMETER OF BOLT.
F = 1½D + ⅛" - ACROSS FLATS
L = 1¾D + ⅛" - " CORNERS
K = 1.414F " "
FIG. 1
FIG. 2.

PLATE 14

MACHINE SCREW HEADS.

HEXAGON

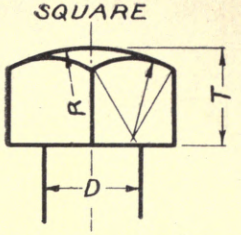


$T = D = R \quad R = 2D$

ACROSS FLAT = B

$$B = \begin{cases} D + \frac{3}{16}'' \text{ WHEN } D < \frac{1}{2}'' \\ D + \frac{1}{4}'' \text{ WHEN } D > \frac{1}{2}'' \end{cases}$$

SQUARE

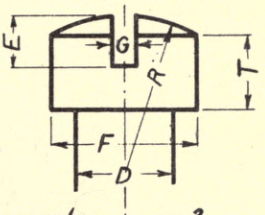


$T = D \quad R = 1\frac{1}{2}D$

ACROSS FLAT = B

$$B = \begin{cases} D + \frac{1}{8}'' \text{ WHEN } D < \frac{3}{4}'' \\ D + \frac{1}{4}'' \text{ WHEN } D > \frac{3}{4}'' \end{cases}$$

FILLISTER.

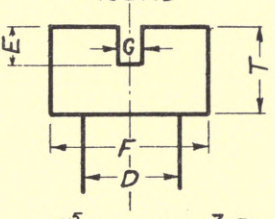


$F = 1\frac{1}{2}D \quad T = \frac{3}{4}D$

$R = F \quad E = \frac{1}{2}D$

$G = \frac{1}{4}D$

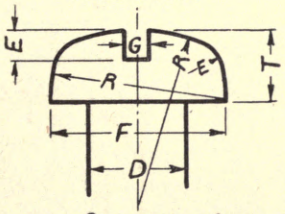
ROUND



$F = 1\frac{5}{8}D \quad T = \frac{7}{8}D$

$E = \frac{3}{8}D \quad G = \frac{1}{4}D$

BUTTON

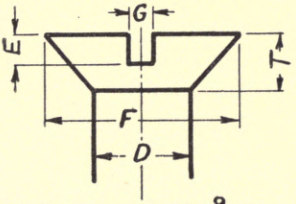


$F = 1\frac{3}{4}D \quad T = \frac{3}{4}D$

$R = F \quad E = \frac{1}{3}D$

$G = \frac{1}{4}D$

COUNTERSUNK



$F = 2D \quad T = \frac{9}{16}D$

$E = \frac{9}{32}D \quad G = \frac{1}{4}D$

PLATE 15

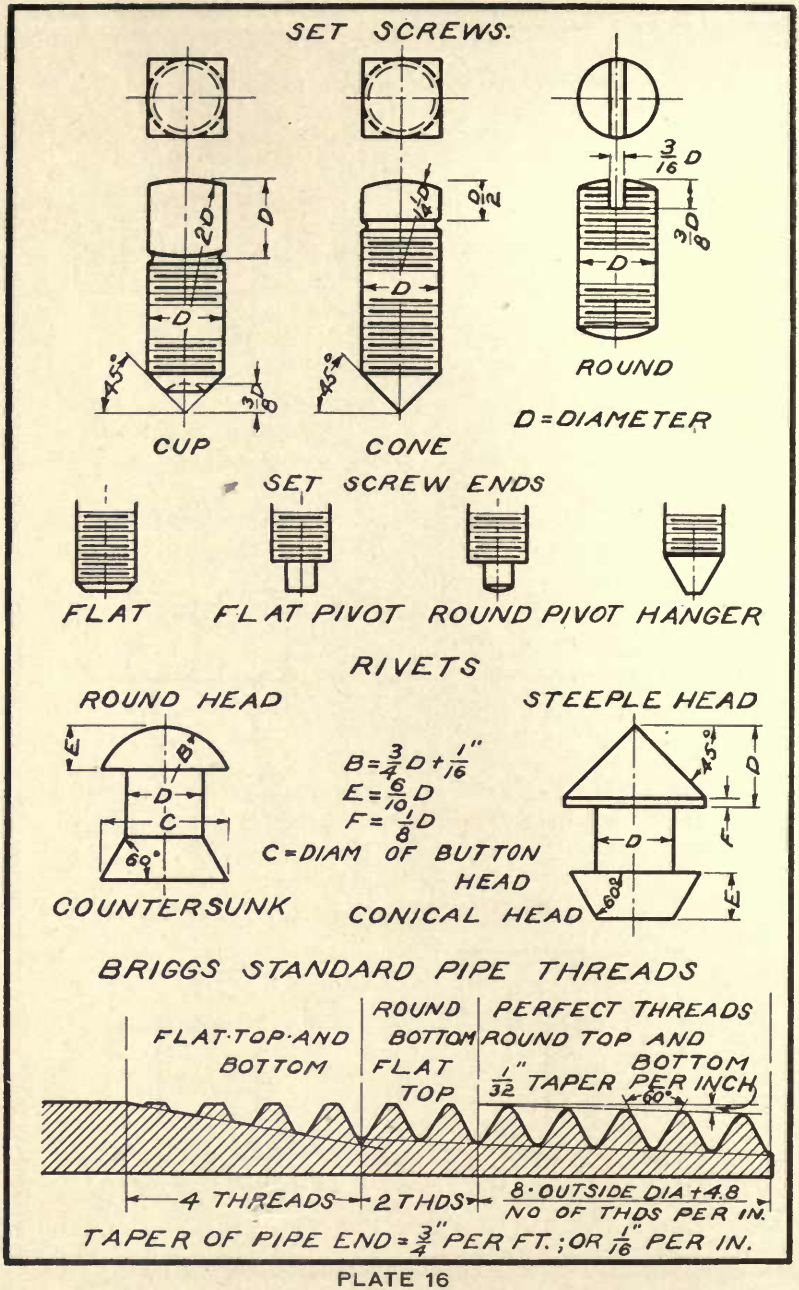

SET SCREWS.
2D
D
45°
3/8 D
CUP
D/2
CONE
3/16 D
3/8 D
ROUND
D = DIAMETER
SET SCREW ENDS
FLAT
FLAT PIVOT
ROUND PIVOT
HANGER
RIVETS
ROUND HEAD
STEEPLE HEAD
B = 3/4 D + 1/16"
E = 6/10 D
F = 1/8 D
C = DIAM OF BUTTON HEAD
60°
COUNTERSUNK
CONICAL HEAD
BRIGGS STANDARD PIPE THREADS
FLAT TOP AND BOTTOM
ROUND BOTTOM FLAT TOP
PERFECT THREADS ROUND TOP AND BOTTOM
1/32" TAPER PER INCH
4 THREADS
2 THDS
8 · OUTSIDE DIA + 4.8 / NO OF THDS PER IN.
TAPER OF PIPE END = 3/4" PER FT.; OR 1/16" PER IN.

PLATE 16

LIMITS

78. In cases where great accuracy is needed the workman is required to turn out the piece correct within limits. These vary a hundredth to a ten-thousandth for instance, according to the accuracy required.

79. Limits are expressed decimally. The amount over size is placed above the dimension line after the dimension figure while the amount under size is placed below the dimension line.

PATTERN AND FORGING DRAWINGS

80. There is a growing tendency on the part of manufacturers to send full size pattern drawings showing core prints, draft, allowance for finish, parting lines, etc., into the die sinking or pattern rooms. These drawings are usually inked in on the original pencil work to avoid the distortion produced by the tracing cloth and blue printing. Pattern and die drawings are usually made by experienced pattern or die makers who have been trained in drafting. Such drawings are intended to supplement the ordinary drafts made by each pattern maker or the foreman.

81. Pattern drawings should contain certain notes to assist the pattern maker such as "Break all sharp edges except as noted," etc.

82. Forging drawings should be very explicit in regard to the shape of the part. All centers should be located and drafts shown. Dimensions not related to or required by the pattern or die maker's work need not be shown.

CHECKING DRAWINGS

1. See that projections and sections are correct.
2. On assembly drawings check for interference and clearances.
3. See that general conventions and standards have been observed.
4. Check all dimensions in regard to arrangement and accuracy.
5. See that all finished surfaces are marked.
6. See that the bill of material is complete and correct.
7. See that the title and drawing number are correct.
8. Check all notes for arrangement.
9. See that proper weights of lines and size of letters and figures have been used and that the drawing is correct in every detail.

LIMITS

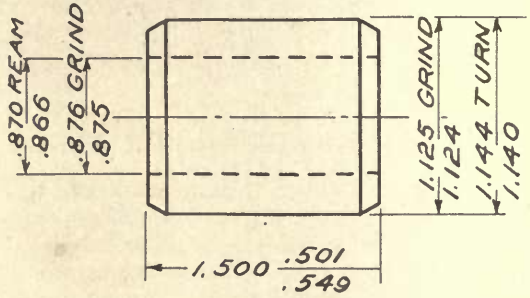
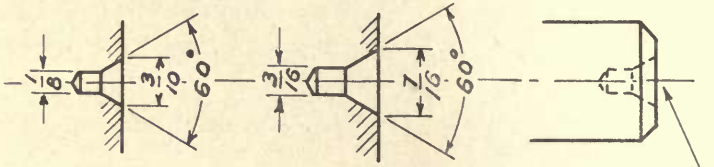


FIG. 1.

CENTERS FOR GRINDING



"B" CENTER "G" CENTER B CENTER

FIG. 2.

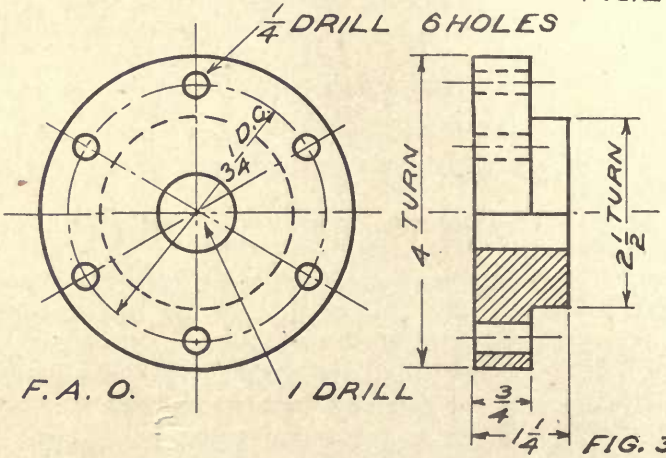


FIG. 3

PLATE 17

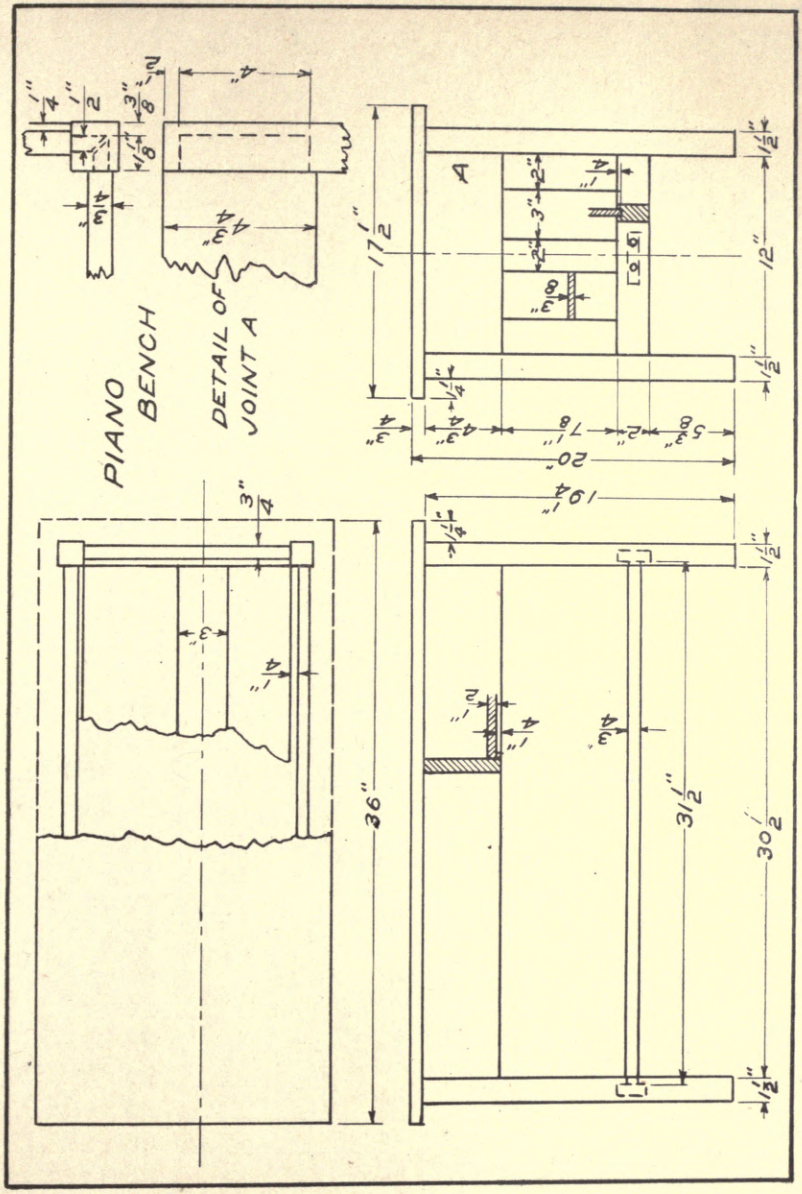


PLATE 18

DECIMAL EQUIVALENTS OF FRACTIONAL PARTS OF ONE INCH

1/64	.015625	33/64	.515625
1/32	.03125	17/32	.53125
3/64	.046875	35/64	.546875
1/16	.0625	9/16	.5625
5/64	.078125	37/64	.578125
3/32	.09375	19/32	.59375
7/64	.109375	39/64	.609375
1/8	.125	5/8	.625
9/64	.140625	41/64	.640625
5/32	.15625	21/32	.65625
11/64	.171875	43/64	.671875
3/16	.1875	11/16	.6875
13/64	.203125	45/64	.703125
7/32	.21875	23/32	.71875
15/64	.234375	47/64	.734375
1/4	.25	3/4	.75
17/64	.265625	49/64	.765625
9/32	.28125	25/32	.78125
19/64	.296875	51/64	.796875
5/16	.3125	13/16	.8125
21/64	.328125	53/64	.828125
11/32	.34375	27/32	.84375
23/64	.359375	55/64	.859375
3/8	.375	7/8	.875
25/64	.390625	57/64	.890625
13/32	.40625	29/32	.90625
27/64	.421875	59/64	.921875
7/16	.4375	15/16	.9375
29/64	.453125	61/64	.953125
15/32	.46875	31/32	.96875
31/64	.484375	63/64	.984375
1/2	.5	1	

WESLEY DUXBURY

PLATE 19

U.S. STANDARD THREADS BOLTS AND NUTS

DIAMETER	NO. OF TH'DS PER INCH	DIAMETER AT ROOT OF THREAD	DIAMETER OF TAP DRILL	DIMENSIONS OF NUTS AND BOLT HEADS				
				ACROSS FLATS	ACROSS CORNERS OF HEX.	ACROSS CORNERS OF SQUARE	THICKNESS OF NUT	HEIGHT OF HEAD
1/4	20	0.185	13/64	1/2	0.578	0.707	1/4	1/4
5/16	18	0.240	1/4	19/32	0.686	0.840	5/16	19/64
3/8	16	0.294	5/16	11/16	0.794	0.972	3/8	11/32
7/16	14	0.345	23/64	25/32	0.902	1.105	7/16	25/64
1/2	13	0.400	27/64	7/8	1.011	1.237	1/2	7/16
9/16	12	0.454	15/32	31/32	1.119	1.370	9/16	31/64
5/8	11	0.507	17/32	1 1/16	1.227	1.502	5/8	17/32
3/4	10	0.620	41/64	1 1/4	1.444	1.768	3/4	5/8
7/8	9	0.731	3/4	1 7/16	1.660	2.033	7/8	23/32
1	8	0.838	55/64	1 5/8	1.877	2.298	1	13/16
1 1/8	7	0.939	31/32	1 13/16	2.093	2.563	1 1/8	29/32
1 1/4	7	1.064	1 3/32	2	2.310	2.828	1 1/4	1
1 3/8	6	1.158	1 7/32	2 3/16	2.527	3.093	1 3/8	1 3/32
1 1/2	6	1.283	1 11/32	2 3/8	2.743	3.358	1 1/2	1 3/16
1 5/8	5 1/2	1.389	1 27/64	2 9/16	2.960	3.623	1 5/8	1 9/32
1 3/4	5	1.490	1 17/32	2 3/4	3.176	3.889	1 3/4	1 3/8
1 7/8	5	1.615	1 21/32	2 15/16	3.393	4.154	1 7/8	1 15/32
2	4 1/2	1.711	1 49/64	3 1/8	3.609	4.419	2	1 9/16
2 1/4	4 1/2	1.961	2 1/64	3 1/2	4.043	4.949	2 1/4	1 3/4
2 1/2	4	2.175	2 15/64	3 7/8	4.476	5.479	2 1/2	1 15/16
2 3/4	4	2.425	2 31/64	4 1/4	4.909	6.010	2 3/4	2 1/8
3	3 1/2	2.629	2 1/16	4 5/8	5.342	6.540	3	2 5/16
3 1/4	3 1/2	2.879	2 5/16	5	5.775	7.070	3 1/4	2 1/2
3 1/2	3 1/4	3.100	3 1/64	5 3/8	6.208	7.600	3 1/2	2 11/16
3 3/4	3	3.317	3 3/8	5 3/4	6.641	8.131	3 3/4	2 7/8
4	3	3.567	3 5/8	6 1/8	7.074	8.661	4	3 1/16
4 1/4	2 7/8	3.798	3 27/32	6 1/2	7.508	9.191	4 1/4	3 1/4
4 1/2	2 3/4	4.028	4 3/32	6 7/8	7.941	9.721	4 1/2	3 7/16
4 3/4	2 5/8	4.255	4 5/16	7 1/4	8.374	10.252	4 3/4	3 5/8
5	2 1/2	4.480	4 9/16	7 5/8	8.807	10.782	5	3 13/16
5 1/4	2 1/2	4.730	4 13/16	8	9.240	11.312	5 1/4	4
5 1/2	2 3/8	4.953	5 1/32	8 3/8	9.673	11.842	5 1/2	4 3/16
5 3/4	2 3/8	5.203	5 9/32	8 3/4	10.106	12.373	5 3/4	4 3/8
6	2 1/4	5.423	5 1/2	9 1/8	10.539	12.903	6	4 9/16

PLATE 20

TRACING

It is often desirable to make a more permanent and serviceable record of a drawing than would be possible if only the inked original drawing were used. To accomplish this a tracing of the penciled drawing is made on tracing cloth. From this tracing as many blue-prints as desirable may be made—these are durable, since they will withstand the wear and the danger of erasure from the weather and hard usage.

The tracing cloth should be cut somewhat larger than the drawing, so that the thumb-tack holes may be removed when the tracing is trimmed to the proper size. This can readily be done, since 36″ cloth actually measures 37″ wide, being 36″ wide between the red lines near the edge.

Tack the cloth down to the board so that it will be tight and free from wrinkles, as the tracing may be done more rapidly. The cloth should have no creases or breaks in it from ill usage. Either the dull or the glossy side of the cloth may be used. A great many prefer and use the dull side because in the drafting room corrections in pencil may more readily be made on this side than on the glossy side.

Dust the surface over with chalk, magnesia or talcum powder. Rub this lightly into the surface and brush all the loose particles off thoroughly to rid the surface of grease and grit and to insure a ready flow of the ink.

In order to maintain a uniform width of line throughout keep the same amount of ink in the pen, about a quarter of an inch at the most. Keep the pen clean. It will be necessary to clean the pen often, as little particles of chalk will be picked up which interfere with the even flow of the ink. If it is impossible to complete the whole tracing at one sitting finish one part, including circles, straight lines, medium and fine. This is most desirable, as the cloth is liable to stretch during the intervening time between sittings, making it difficult to readjust the tracing to the drawing.

Erasing—Use an ordinary eraser in erasing. Never use one with sand in it. Never use a steel eraser. These either destroy the surface of the cloth, making it impossible to retrace, or a hole is cut in the cloth, ruining the whole tracing. After erasing it is often necessary to build up from a fine line to one of full weight.

University of California
SOUTHERN REGIONAL LIBRARY FACILITY
Return this material to the library
from which it was borrowed.

SEP 24 1990

SEP 24 1990

UC SOUTHERN REGIONAL LIBRARY FACILITY
A 000 038 642 5

Univ
S